APPENDIX B

Name	Organization	Telephone No.	Facsimile No.
Leslie Taylor	LTA for QualComm	(301) 229-8341	(301) 229-3148
Ron Lepkowski	Constellation Communications	(703) 352-1733	(703) 352-9279
Alan Rinker	CSS/NASA	(703) 834-5606	(703) 487-9401
Michael French	Comm. Daily	(202) 872-9200	(202) 293-3435
Francis Williams	FCC	(202) 653-8126	(202) 653-8773
Ken Keane	Winston & Strawn	(202) 371-5775	(202) 371-5950
Harry Ng	FCC	(202) 634-1834	(202) 634-6625
Sam Nguyen	Comsat Mobile	(301) 428-2346	(301) 601-5959
Bob Huang	Consultant	(703) 866-0375	(703) 866-6045
Jim Vorhies	NTIA	(202) 482-1138	(202) 482-4396
Lon Levin	AMSC	(703) 758-6150	(703) 758-6111
Glenn Richards	Fisher, Wayland	(202) 775-5678	(202) 296-6518
T. Stephen Cheston	Iridium	(202) 326-5674	(202) 842-0006
James G. Ennis	Iridium	(202) 326-5677	(202) 842-0006
Barry Lamberuman	Motorola	(202) 371-6929	(202) 842-3578
Gerald B. Helman	MCHI	(202) 466-4488	(202) 466-4493
Tomas E. Gergely	NSF	(703) 306-1823	(703) 306-0525
Bob May	Air Force	(703) 696-0662	(703) 696-0798
Gerry Wiggen	SFA, Inc.	(301) 925-9400	(301) 925-8612
Jim Carroll	SFA, Inc.	(301) 925-9400	(301) 925-8612
Kaye Nilson	CompassRose Intl.	(202) 833-2350	(202) 466-3055
Martin Bercovici	Keller & Heckman	(202) 434-4144	(202) 434-4651
William F. Adler	Fleischman & Walsh	(202) 939-7900	(202) 745-0916
Ray Crowell	Comsat	(301) 214-3466	(301) 214-7100
Larry Olson	FCC	(202) 632-6955	(202) 653-9659
Steve Sharkey	FCC	(202) 653-8151	(202) 653-8773
Warren Richards	Dept. of State	(202) 647-0049	(202) 647-7407
Diane Garfield	Dept. of State	(202) 647-5820	(202) 647-0158
Kathryn Martin	Dept. of State	(202) 647-0198	(202) 647-7407
Don Jansky	JBTI	(202) 467-6400	(202) 296-6892
Thomas Keller	VLBM&H	(202) 371-6060	(202) 371-6279
Edward F. Miller	Teledesic	(202) 416-6526	(202) 223-9095
Ben C. Fisher	Fisher Wayland	(202) 775-3537	(202) 296-6518
Michael L. Richmond	NTIA	(202) 482-1164	(202) 482-4396
Jack Wengryniuk	Comsat Labs	(301) 428-5027	(301) 428-9287
Mary Britton	Latham & Watkins	(202) 637-2117	(202) 637-2201
Gary Epstein	Latham & Watkins	(202) 637-2700	(202) 637-2201
Thomas Walsh	FCC	(202) 418-0420	(202) 418-2818
F.S. Urbany	Bellsouth	(202) 463-4110	(202) 463-4198
Gene Rappoport	AT&T	(908) 234-6230	(908) 234-8681
Paul L. Rinaldo	ARRL	(202) 296-9107	(202) 293-1319
William A. Luther	FCC	(202) 418-1112	(202) 632-0160
Mario Florian	Orbcomm	(703) 406-5305	(703) 406-3508
Robert Mazer	Rosenman & Colin	(202) 463-7177	(202) 429-3902
Bennett Kobb	New Signals	(703) 715-6165	(703) 920-6853
Ed Reinhart	Consultant (HAC)	(703) 448-9552	(703) 448-5920
Kristi Kendall	FCC	(202) 634-7058	(202) 634-6625
Robert M. Taylor	NASA	(202) 358-4851	(202) 358-3520
John Kiebler	MITRE	(301) 901-9213	(301) 901-9209

David Struba	NASA	(202) 358-4808	(202) 358-3520
Robert Briskman	CD Radio	(202) 296-6840	(202) 296-6265
Carl Frank	CD Radio/ARINC/McCaw	(202) 429-7269	(202) 429-7049
W.J. Blackburn	Ericsson-GE	(804) 528-7391	(804) 528-7015
John E. Miller	STel	(301) 464-8900	(301) 262-2642
Alejandra Ornés	Iridium	(202) 326-5676	(202) 842-0006
Tom Sullivan	CSC/AMSC	(301) 731-2231	(301) 731-2238
Dick Evans	AMSC	(703) 758-6000	(703) 758-6111
Alan Renshaw	STARSYS, Inc.	(301) 459-8832	(301) 794-7106
Benito Gutierrez-Luaces	NASA HQ	(202) 453-1424	(202) 453-1292
Christine DiLapi	Motorola	(602) 732-4169	(602) 732-2305
James R. Carroll	SFA	(301) 925-9400	(301) 925-8612
Kris Hutchison	ARINC	(410) 266-4386	(410) 266-2047
Damon C. Ladson	FCC/OIC	(202) 418-0420	(202) 418-2818
Philip L. Malet	Steptoe & Johnson	(202) 429-6239	(202) 429-3902
Richard Swanson	FCC	(202) 632-7197	(202) 634-7651
Thomas Walsh	FCC	(202) 418-0420	(202) 418-2818
Alex Latker	FCC	(202) 418-1488	(202) 418-2818
Edward M. Davison	NTIA	(202) 482-1164	(202) 482-4396
Ronald Repasi	FCC	(202) 634-1841	(202) 634-6625
Frank Willico	FCC	(202) 653-8126	(202) 653-8773
L.R. Raish	Fletcher, Heald	(703) 812-0480	(703) 812-0486
Richard Barth		(301) 763-4643	(301) 420-0932
Cecily Holiday	FCC	(202) 634-1629	(202) 634-6625
Jennifer A. Manner	Akin, Gump	(202) 887-4576	(202) 887-4288
Beverly Sincavage	LTA/LQP	(301) 229-9341	(301) 229-3148
Rich Wright	CSC	(703) 834-5600	(703) 487-9401
Richard Schlapia	Commerce	(301) 763-4643	(301) 420-0932
Byung K. Yi	CTA	(301) 816-1327	(301) 816-1426
Gordon Law	VITA	(703) 276-1800	(703) 243-1865
Burt Levin	Final Analysis	(301) 474-0111	(301) 474-3228
Don Erat	Final Analysis	(301) 474-0111	(301) 474-3228
Ron Jarvis	Catalano & Jarvis	(202) 338-3500	(202) 338-3003
LCDR Teresa Gobel	OFCM	(301) 427-2002	(301) 427-2007
David McGinnis	Commerce/NOAA	(301) 763-4715	(301) 420-0932
Richard Chitty	CTA	(301) 816-1347	(301) 816-1416
Brett Wilson	Rockwell	(703) 412-6635	(703) 412-6868
Alan Parker	Orbcomm	(703) 406-5300	(703) 406-3508

FCC INDUSTRY ADVISORY COMMITTEE

FOR THE

ITU 1995 WORLD RADIO COMMUNICATION CONFERENCE

~ ~ ~ ~

INTERIM REPORT

OF

INFORMAL WORKING GROUP 2

~ ~ ~ ~

Donald M. Jansky
Chair

Kathryn A. Martin
Vice Chair

OUTLINE OF IWG-2 INTERIM REPORT

1.0 INTRODUCTION

2.0 REQUIREMENTS

3.0 EXISTING ALLOCATIONS

- 3.1 EXISTING BANDS
- 3.2 SHARING PROBLEMS
- 3.3 RECOMMENDATIONS

4.0 ADDITIONAL ALLOCATIONS

- 4.1 CANDIDATE SPECTRUM ALLOCATIONS
- 4.2 SHARING ISSUES
- 4.3 ALLOCATION APPROACHES
- 4.4 RECOMMENDATIONS

5.0 PROCEDURES

- 5.1 USE OF RESOLUTION 46
- 5.2 RECOMMENDATIONS

6.0 INTERNATIONAL VIEWS

- 6.1 ITU-R (TG 8/3)
- 6.2 CEPT
- 6.3 CITEL
- 6.4 CANADA
- 6.5 OTHER

7.0 PROPOSALS

- 7.1 ALLOCATIONS
  - 7.1.1 REVISIONS TO EXISTING
  - 7.1.2 ADDITIONAL ALLOCATIONS
- 7.2 SHARING CRITERIA
  - 7.2.1 EXISTING ALLOCATIONS
- 7.3 PROCEDURES (Resolution 46)

8.0 APPENDICES

- 8.1 ITU-R SHARING PAPERS
- 8.2 OTHER

9.0 DOCUMENT LIST

INFORMAL WORKING GROUP 2 - MSS BELOW 1 GHZ

INTERIM REPORT

1.0 INTRODUCTION

At the initial FCC Industry Advisory Committee (May 31, 1994) in preparation for the 1995 World Radiocommunication Conference, the FCC created several informal Working Groups to consider the various aspects of the previously established WRC 95 agenda. The second working group, IWG-2, was created to draft and justify, for the IAC's consideration, recommendations for U.S. proposals and positions on:

1. spectrum requirements for the mobile-satellite service (MSS) below 1 GHz;

2. additional frequency bands that could be allocated to MSS below 1 GHz;

3. technical and operational constraints associated with the presently and potentially allocated frequency bands below 1 GHz to MSS with a view toward facilitating the use of these bands;

4. addition(s) to/modifications of the relevant Radio Regulations

5. resolutions and recommendations, if any, of World Administrative Radio Conferences which are relevant to the aforementioned items 1, 2 and 3.

As part of its Terms of Reference, IWG-2 is required to support its recommendations for U.S. proposals and positions by narrative text that indicates (a) the amount, and basis for determination of spectrum needed, (b) the placement in the spectrum of additional MSS allocations (c) the unmet spectrum requirements for MSS below 1 GHz, if any; (d) the appropriate sharing criteria; (e) the time frame associated with any unmet spectrum requirements and any reaccommodation that may be required of existing services; and (f) any consequential changes needed to the international Radio Regulations in order to implement the suggested changes/allocations.

Mr. Donald Jansky was appointed Chairman of the Working Group; Ms. Kathryn Martin was appointed Vice-Chairman; and Ms. Kristi Kendall was appointed the FCC Contact.

In order to undertake its studies according to the requirements of its terms of reference, IWG-2 adopted a Work Program for IWG-2 which consisted of the following elements:

Agenda Item 2.1 (a)

Allocated Spectrum - IWG-2 was requested to evaluate and develop new or modify existing technical constraints, if necessary, on spectrum allocated to MSS Below 1 GHz on a primary basis (specifically 137-138 MHz, 148-149.9 MHz, 149.9-150.05 MHz and 400.15-401 MHz) with a view toward enhancing its use for non-voice, non-geostationary (NGSO) MSS, including an analysis of all footnotes, resolutions, recommendations, and provisions of the Radio Regulations applicable to this spectrum.

Technical and Operational Criteria Concerning Existing Services - Reviewing any dates associated with certain parts of the Radio Regulations, coordination triggers, classes of allocation and sharing criteria available within the Radio Regulations, ITU-R Bureau rules of procedure and ITU-R Recommendations to determine adequacy for use with the NGSO MSS. In addition, IWG-2 was given the option of considering improvements to existing secondary MSS allocations to facilitate their use for NGSO MSS and providing any other sharing criteria required to maintain compatible operations between the planned NGSO MSS and other radio services operating in the allocated frequency bands.

Agenda Item 3(d)

New Allocations - Estimate additional bandwidth requirements for NGSO MSS and identify preferred frequency bands with a view toward obtaining limited primary or secondary allocations in 1995. To this extent, provide analysis of any necessary technical and/or operational criteria for other services in candidate bands. IWG-2 was also requested to determine the ability of several NGSO systems to share spectrum and the impact this sharing ability has on the bandwidth requirement, and indicate projected time frames within which new allocations will be needed and existing services can be reaccommodated.

Agenda Item 5

Regulatory Provisions - Together with IWG-3 (MSS Above 1 GHz), IWG-2 was requested to develop any regulatory provisions necessary to coordinate and implement NGSO MSS below 1 GHz with existing services. To this end, it should evaluate Resolution 46 and other Regulatory provisions with a view toward defining any changes that will be beneficial to the development of the U.S. NGSO MSS industry.

The Working Group also examined the question of future agendas, and plans to provide its recommendations for future agenda items to the IAC.

IWG-2 met ten times to undertake its studies. The IWG had full participation from a variety of industry representatives and several observers from U.S. Government agencies.

The following is an interim report of its activities and findings. The next four sections explore the questions regarding Requirements, Allocations, Sharing Criteria and Resolution 46. The IWG also considered many foreign views in its deliberations, and section 6.0 provides an analysis of relevant international views to provide a context from which the IWG has made its recommendations. IWG-2's recommended proposals and positions are contained within section 7.

2.0 REQUIREMENTS

At WARC'92 1.525 MHz of spectrum was allocated Primary for space-to-Earth operations and 1.9 MHz of spectrum was allocated Primary for Earth-to-space operations for a total of 3.425 MHz. An additional 6.475 MHz of spectrum was allocated Secondary for up and downlinks, with 150 KHz of this spectrum (149.9-150.05 MHz Earth-to-space) to be changed to Primary allocation effective January 1, 1997. Six MHz of this Secondary allocation is in the 300 MHz band, which is regarded by the U.S. Government as unavailable for domestic commercial MSS services. Footnotes to the WARC-92 Primary allocations afford special protection to existing services operating under Primary status in all spectrum allocated to non-geostationary MSS.

In January 1993, the Federal Communications Commission (FCC) adopted the WARC-92 spectrum allocations in the United States with one addition. The so-called upper "Transit" band at 399.9-400.05 MHz (150 KHz) was allocated as a Primary uplink effective January 1, 1997.

In October 1993, the FCC adopted U.S. domestic regulations governing the licensing and provision of the new MSS services and limited the new service to non-voice non-geostationary (NGSO).

In October 1994, the FCC announced the opening of a second round of applicants for below 1 GHz non-GSO MSS. Five companies submitted second round applications, and two others proposed modifications requiring additional spectrum. Based on detailed market studies conducted by U.S. organizations planning and constructing MSS below 1 GHz systems and independent studies, the demand for the new low-cost, ubiquitous services is expected to be large and fast growing. However, in-depth technical sharing analyses and on-orbit measurements of spectrum usage and radiated power show clearly that the allocated spectrum is heavily used by the existing terrestrial services, and the less-used spectrum will be insufficient to accommodate all ITU-BR published systems and U.S. second round applications to operate simultaneously while providing reliable and commercial grades of service.

2.1 Demand for NGSO Services

Although NGSO spectrum is limited, market demand is expected to be high. Studies to determine demand for the new NGSO services in the U.S. and internationally have been in progress for over five years. The outlook for these services resulted in

worldwide support for allocations and licensing of initial systems. Projections for subscriber demand are based upon the following characteristics of NGSO services:

- Low-Cost Subscriber Equipment and Services Resulting From use of VHF/UHF Frequencies, Data Transmission Only, and Low Investment Requirements

- Two-Way Ubiquitous Global Communications Capability for the First Time Combined with Low Subscriber Costs

- Enabling technologies such as Pocket Portability and Long Battery Life, Two Fundamental Requirements in Numerous Applications

- Interconnectivity and Compatibility with e-Mail Systems

- Complementary with Mobile Computers and GPS Devices

In addition to the characteristics of MSS services below 1 GHz, other key factors are driving demand for the new services:

- Enormous growth in computer availability and usage that has demonstrated to millions of people the benefits of alphanumeric communications and has made people comfortable with use of keyboards. In the U.S. there are an estimated 35 million people connected to an e-mail service. Over 10 million people around the world are connected to the Internet, 1,000 computers are added each day to the Net, and traffic is growing at 10 percent a month.

- Simultaneous explosion in the use of mobile communications services with the resulting demand for mobile computing and e-mail services. In the U.S. over 40 million persons work on a regular basis away from a fixed site.

- Growth in awareness of the benefits of mobile communications to business and for personal convenience and urgent, high priority messaging. This is manifested in the rapid growth in cellular subscribers in the U.S. to over 16 million and in paging subscribers to almost 20 million.

- The urgent demand for data communications in lesser developed countries that do not have extensive land-line communications infrastructure.

- Recognition among commercial shipping companies and truck fleet operators that they can achieve substantial efficiencies by using low-cost MSS tracking, identification and messaging services virtually anywhere around the globe.

- The growing need for environmental data collection for numerous governments, agencies, and individual companies.

- A rising theft problem of high value cargo and vehicles in virtually every country.

- The ability of MSS systems below 1 GHz to provide data messaging, positioning, and file transfers to areas around the world by reusing small amounts of spectrum as the satellites circle the Earth.

MSS services are widely perceived as being the long-sought, practical way to fill the last large gap in the worldwide telecommunications network---convenient two-way communications capability everywhere on Earth at affordable prices. Subscriber communication equipment is expected to be priced between $100 and $400 retail. Service pricing is expected to range from as low as $25 per year to $100 per month depending on the type of service and usage.

2.2 Expected Growth

The view that NGSO MSS services will find widespread market acceptance is supported by the number of systems that have been announced around the world or are known to be at some stage of development. In the U.S., in addition to the three applicants included in the first processing round, four companies have requested experimental authority to use the allocated spectrum, and one has received such authority. A second processing group was initiated by the FCC in late 1994 resulting in five new system proposals. Outside the U.S., system plans have been announced in twelve countries including Mexico, Brazil, Russia, India, France, Italy, Germany, Australia, Korea, Belgium, Tonga, and Uganda.

Detailed discussions with hundreds of potential user groups around the world have substantiated the requirement for MSS services operating below 1 GHz and have led to significant investments in system development, construction, and pre-operational marketing. Initial commercial services are scheduled to begin in 1995.

Based on independent studies of potential demand and data released by organizations planning NGSO systems, by the year 2000 approximately six million subscribers will use these services, (see IWG-2-6 (Rev.2). Of this number, about two million subscribers are projected in the U.S., and almost four million, or two-thirds of the world's total, are anticipated outside the U.S. Services will include emergency/SAR services, data acquisition and monitoring, tracking and messaging. NGSO MSS systems are projected to account for 20 percent of the worldwide wireless e-mail market by the year 2003 which is valued in total at over $5 billion. These projections do not include potential requirements for OEM automotive installation which could increase

the underlying demand by tens of millions of subscribers in the U.S. alone.[1]

It is estimated, based on capacity studies using conventional busy hour analyses, that the allocated spectrum may be sufficient to meet demand in the U.S. through 1999. If this is the case, about 1.5 million U.S. subscribers will be serviced while occupying only 3.425 MHz of Primary spectrum or almost 500,000 subscribers per megahertz. Replacement systems that would be launched in the 1999 to 2003 period would be severely restricted in their ability to increase capacity within the existing allocations, notwithstanding advances in technology.

A telecommunications service that grows from zero subscribers to six million in five years will not have approached a slackening of demand growth. Extrapolating the projections on a straight line basis to 2005, a worldwide subscriber base of about nine million can be expected, increasing to 14 million by 2010. However, a subscriber base of 15 million might be achieved by 2005 if demand grows at the more probable exponential rates experienced by other mobile services, such as cellular telephones. This would imply a worldwide subscriber demand of 25 million by 2010. Moreover, addition of OEM automotive applications would be expected to increase these by more than ten times.

Replacement and additional MSS systems needed to meet these levels of demand must be planned, designed, financed, and constructed beginning in 1996 through 1998. Without the allocation of additional spectrum at WRC-95 and/or WRC-97, these systems may not be built and growing demand will not be met.

---

[1] Publicly Available References:

- Wireless Electronic Mail & Facsimile Markets, Worldwide, November 1993, International Resource Development Inc.
- The Market for Mobile Satellite Services: Prospects for LEOs and GEOs, June 1994, Leslie Taylor Associates
- ISSO Conference, Washington, D.C., June 1994, Orbital Communications Corporation
- Developments on the Mobile Data Communications Market, June 1992, Arthur D. Little Inc.
- Portable Computers & Wireless Communications, Third Quarter 1993, DataComm Research Company

2.3 Level of Additional Spectrum Requirements to NGSO and Other MSS Services Operating Below 1 GHz

Additional spectrum allocations need to be made at WRC-95 and WRC-97 to meet growth requirements for the type of NGSO MSS services planned to be offered by the initial system operators, as well as to allow developments of a range of expanded service offerings to meet the demands of subscribers for added capabilities. Additional allocations must take account of regulatory, planning and construction spans. Typically there is a minimum period of five or six years from the time allocations are made at an ITU radio conference and operational availability of a new system using the new allocations. To accommodate spectrum and schedule requirements, allocations must be made at the next two conferences and must meet expected spectrum requirements through the year 2010.

Assuming that the subscriber-per-megahertz of bandwidth ratio projected for the initial NGSO systems is constant through the planning period (500,000 per MHz) and that North American requirements drive capacity requirements and, in turn, spectrum requirements, additional worldwide Primary allocations of a minimum of seven MHz will be required around 2000 and 13 MHz will be required by 2010.

It is likely however that these numbers will be much higher. Because MSS systems operating at higher frequencies require far more expensive space segments and subscriber equipment than do those operating at lower frequencies, subscribers will inevitably demand increased functionality from MSS service providers operating below 1 GHz. This means capability for longer messages, value added information services and other telecommunications services. The existing allocations are unable to support transmission of longer messages, data/information files, facsimile and similar services. Thus, future spectrum allocations should more realistically provide for expansion of services that MSS systems can offer in these bands.

Establishing specific spectrum requirements to accommodate these expanded services cannot be precise. However, it appears reasonable to assume that an increase of about 50 percent over the additional spectrum needed to meet growth of the basic NGSO services will be required. Thus the total <u>additional</u> allocations which must be available for implementation for MSS below 1 GHz to meet market demand are ten MHz by 2000 and 20 MHz by 2010.

3.0 EXISTING MSS ALLOCATIONS BELOW 1 GHZ

This section describes the situation regarding MSS allocations below 1 GHz and identifies possible allocations which might be considered for future proposed additional MSS allocations below 1 GHz.

3.1 Existing Allocations

The Table below indicates the footnotes pertaining to international MSS allocations below 1 GHz. It also shows related frequency bands and certain regulatory provisions.

Table 1.0

MSS allocation and status (MHz)	Quantity of Spectrum (MHz)	MSS FN	Other Services and Footnotes
137-137.025 co-primary (s-E) 137.025 - 137.175 secondary (s-E) 137.175 - 137.825 co-primary (s-E) 137.825 - 138 secondary (s-E)	0.025 0.15 0.650 0.175	 599A 599B 	SPACE OPERATION (s-E) MET.SAT (s-E) SPACE RESEARCH (s-E) Fixed Mobile except aeronautical mobile (R) 596 597 598 599 599A
148 - 149.9 co-primary (E-s)	1.90	599A 608A 608C	FIXED MOBILE (except aeronautical mobile (R) - Region 1) 608 608A 608C
149.9 - 150.05 (LMSS) (E-s) co-primary after 1 January 1997	0.15	599B 609B	RADIONAVIGATION SATELLITE 608B 609 609A
235 - 322 and 335.4 - 399.9 secondary	151.5 (Article 14) Resolution 46 does not apply	641	FIXED MOBILE 641 641A
312 - 315 secondary (E-s)	3.0 (Article 14)	641A	FIXED MOBILE 641 641A
387 - 390 secondary (s-E)	3.0 (Article 14)	641A	FIXED MOBILE 641 641A
400.15 - 401 co-primary (s-E)	0.85	647B	MET.AIDS MET.SATELLITE (s-E) SPACE RESEARCH (s-E) SpaceOperations (s-E) 647 647B
806 - 890 primary (Region 2 only)	84 (Article 14) Resolution 46 does not apply	700	FIXED MOBILE

As indicated above, the 3.42 MHz of bandwidth allocated to MSS below 1 GHz on a Primary basis (the Base-Allocation) will be insufficient to accommodate present systems. To compound this problem, the Base-Allocation, which must provide for both subscriber and feederlinks in-band, is shared with other services also allocated on a Primary basis. To protect these other services, the following international and domestic restrictions, both operational and regulatory, have been imposed upon MSS systems below 1 GHz.

. 148-149.9 MHz Uplink (1.9 MHz)

- U.S. Footnote 323 establishing mobile terminal transmission duration, duty cycle and pfd limitations
- Non-Interference Sharing with Tens of Thousands of Existing Users Worldwide
- No Always-Clear Spectrum Sub-Bands
- -150 PFD Limit Outside National Border

. 137-138 MHz Downlink (675 KHz)

- PFD Coordination Threshold Limit
- MetSat PFD Thresholds for Coordination (Affects Co-Frequency CDMA System)

. 400.15-401 MHz Downlink (850 KHz)

- Existing/Planned Systems Restrict MSS Usage in 710 kHz of the 850 kHz available

The spectrum allocated on a Secondary basis at 137-138 MHz (downlink) is encumbered by PFD coordination threshold criteria, beyond the -125 dB limit, for protection of the MetSat Primary services that will require coordination by any type of NGSO system desiring to operate in the Secondary allocation.

In the 300 MHz bands, the allocation in the U.S. is for government (non-commercial) use only. These bands lie within the 225-400 MHz band where the principal use is for tactical operations (joint U.S. and European allies); and air-ground, air-air and ground-ground communications. In the U.S., 235-322 and 335.4-399.9 MHz is allocated to non-commercial MSS only. Non-licensed use of the 300-450 MHz band is permitted for wireless security alarms and garage door openers. The U.S. Government has opposed commercial use in the U.S. of the 225-400 MHz band for MSS operations. However, it is believed that shared use may be possible. It is known that CEPT countries are considering reallocating 380-399.9 MHz to commercial use in Europe for the TETRA emergency system.

The net effect of these restrictions is to limit further the number of NGSO systems that can operate in the spectrum allocated to NGSO service.

3.2 Sharing Issues

During WARC-92 the Low Earth Orbit Mobile Satellite Service (LEO MSS) < 1 GHz allocations were encumbered with certain constraints to provide protection to the existing users of the allocated bands. These constraints were in the form of footnotes to the allocations containing specific technical language to protect the fixed and mobile operators in the 148.0-149.9 MHz, 137-138 MHz and 400.15-401 MHz bands. Radio astronomy operations in nearby bands were given less specific protection.

3.2.1 Existing Fixed and Mobile Services

3.2.1.1 137-138 MHz and 400.15-401 MHz Bands. (Downlink bands)

FN 599a

- Use of the 137-138 MHz band by the mobile satellite service is subject to the coordination and notification procedures set forth in Resolution 46(WARC-92). However, coordination of a space station of the mobile satellite service with respect to terrestrial services is required only if the power flux-density produced by the station exceeds -125 dB(W/m^2/4 kHz) at the earth's surface.

- Administrations shall take all practical steps to protect the radio astronomy service in the 150.05 to 153 MHz band and the 406.1-410 MHz band from harmful interference from unwanted emissions.

Comment: NGSO MSS systems can comply with both the -125 dB(W/m^2/4 kHz) coordination trigger and the protection of the radio astronomy service.

3.2.1.2 148.0-149.9 MHz Band. (Uplink band)

FN 608A

- Use of the band by the mobile satellite service is subject to the application of the coordination and notification procedures of Resolution 46.

- The mobile satellite service shall not constrain the development and use of fixed, mobile and space operation services in the band 148-149.9 MHz.

- Mobile Earth stations in the MSS shall not produce pfd in excess of -150 dB(W/m^2/4 kHz) outside of national boundaries.

Comment: NGSO MSS systems have characteristics which permit sharing with the fixed and mobile systems in the 148.0-149.9 MHz band. However, the restriction of -150

db(W/m²/4 kHz) outside national boundaries has operational and regulatory difficulties. As written, the different systems could require up to 200 kilometers separation for the mobile signal to attenuate to the -150 dB(W/m²/4 kHz) level. This would make it impossible to expect compliance. In addition, no proper propagation model advice has been provided to the ITU-R, nor has a procedure for how to proceed if the pfd limit is exceeded been identified. It is considered that a "threshold" for coordination is a more appropriate method for insuring that transmissions from mobile terminals across borders can be accommodated by countries within a specified distance of one county's borders. Such a method has been developed and should be proposed as a substitution for the approach in this footnote. (See Attachment A)

FN 609C With all of these sharing techniques IWG-2 agrees with TG 8/3 that countries should be encouraged to examine their continuing need for their name on this footnote, consistent with the recommendation of the VGE to reduce country footnotes.

3.2.1.3 149.9-150.05 MHz Uplink Band

FN 608B The use of the band 149.9-150.05 MHz by the land mobile satellite service is subject to the application of the coordination and notification procedures set forth in Resolution 46 (WARC-92). The land mobile satellite service shall not constrain the development and use of the radionavigation-satellite service in the band 149.9-150.05 MHz. Land mobile earth stations of the land mobile-satellite service shall not produce power flux-density in excess of -150 dB(W/m²/4 kHz) outside national boundaries.

Comment: Since this band is not shared with any terrestrial mobile or fixed systems the -150 db(W/m²/4 kHz) restriction portion of the footnote is unnecessary.

3.2.2 Sharing With Other Co-Primary Services in the Existing Bands

In addition to the specific restrictions listed in the ITU frequency allocation footnotes, LEO MSS < 1GHz systems must be able to share the allocated spectrum with other existing co-primary users in each band. Efforts are underway to develop the necessary criteria. Currently, ITU-R Study Group 7C and WP 8D are developing revised sharing criteria for the meteorological satellites in the 137-138 MHz and 400.15-401 MHz downlink bands based on the characteristics of the METSAT systems.

3.2.2.1 Sharing with METSATS

Interstitial FDMA LEO MSS systems are able to share with METSATS simply by avoiding the areas of METSAT use in the band. Since spread-spectrum system signals cover most of the bandwidth at 137-138 MHz and hence must operate in the same channels as METSAT, these systems must use a combination of low pfd at ground level and cross-polarization of the satellite downlink signals to achieve the necessary signal isolation to avoid interference to the various METSAT receivers. In the 400.15-401 MHz band, LEO MSS systems share by avoiding the areas of the band intended for use by METSATS.

3.2.2.2 Sharing with Space Operation, Space Research, and Meteorological Aids

LEO MSS < 1 GHz systems can share with these occasional co-primary users of the downlink bands through the use of one or a combination of sharing techniques. Channel avoidance, low pfd's, band segmentation, and cross polarization can be utilized in different combinations to avoid harmful interference to existing co-primary systems in the allocated bands.

3.2.3 Sharing With Other LEO MSS Users

In order to share the small amount of spectrum allocated to LEO MSS < 1 GHz at WARC-92, the sharing arrangements for common use of the frequency allocations can be based on the requirements and the characteristics of different LEO MSS < 1GHz systems. In the uplink band, band segmentation by type of system permits both FDMA and spread-spectrum transmission techniques to share the uplink band. In the downlink bands, a combination of sharing techniques can be used: channel positioning, cross polarization, and low pfd levels. In this case, systems are required to share with several established co-primary users of the bands as well as with other LEO MSS users, and sharing techniques need to be judiciously selected accordingly.

3.2.4 Ability of NGSO MSS Systems to Operate in the Presence of Existing Users

Table 2 summarizes the sharing issues in existing MSS allocations below 1 GHz bands.

TABLE 2

	Narrow-Band	Wideband
FIXED and MOBILE (148-149.9 MHz)	Combination: - Dynamic channel avoidance - Low duty cycle - Brief message duration - Geographical separation	Combination: - Low output power density - Brief message duration - Low data rate - Filtering at satellite - Geographical separation
FIXED and MOBILE (137-138 MHz) (400.15-401 MHz)	Ground level pfd below -125 db (W/m^2/4 kHz) per FN 599A	Ground level pfd below -125 db (W/m^2/4 kHz) per FN 599A
METEOROLOGICAL SATELLITES (137-138 MHz) (400.15-401 MHz)	Band segmentation	Combination: - Low pfd at ground level - Cross polarization - Adaptive filter at satellite
SPACE OPERATIONS SPACE RESEARCH (137-138 MHz)	Channel avoidance	Combination: - Low pfd - Cross polarization
SPACE RESEARCH (400.15-401 MHz)	Channel avoidance	Combination: - Low pfd - Cross Polarization
METEOROLOGICAL AIDS (400.15-401 MHz)	Channel avoidance	Combination: - Low pfd - Cross polarization
Other MSS SYSTEMS (uplink)	- Band segmentation for spread spectrum systems - Channel avoidance for FDMA systems - Geographic separation	- Band segmentation for FDMA systems - Spectrum sharing for other SSMA systems
OTHER MSS SYSTEMS (downlink)	Combination: - Channel locations - Cross Polarization - Band segmentation	Combination: - Low satellite eirp density - Cross polarization - CDMA - Band segmentation
OTHER MSS SYSTEMS (400.15-401 MHz)	Band segmentation	Band segmentation
RADIOASTRONOMY	Filtering	Filtering

In general, NGSO MSS < 1 GHz systems use either the interstitial FDMA, fixed FDMA or spread-spectrum approach for uplink transmissions from the ground terminals to the satellite. Interstitial FDMA NGSO MSS systems are dependent upon finding vacant channels so as to avoid creating interference to, or receiving interference from fixed and mobile users in the uplink band (148.0-149.9 MHz). Fixed channel FDMA systems will depend upon well surveyed locations and directional antennas to avoid interference to and from existing fixed and mobile users, but these operations are not considered "mobile". Spread-spectrum systems mobile terminals transmit across a wide bandwidth, and therefore must rely upon a very low power output to avoid harmful interference to the more powerful voice channels of the fixed and mobile users. However, spread-spectrum systems are susceptible to multiple large powered transmissions within the same bandwidth, and must have a sufficiently robust system to remain effective in those conditions. Furthermore, spread-spectrum systems using a satellite transponder must be able to process the voluminous and strong fixed and mobile uplink signals at the satellite to prevent their retransmission into the downlink band in such a manner as to avoid causing harmful interference to itself and other systems in the downlink band.

4.0 ADDITIONAL ALLOCATIONS

As the previous sections have indicated there is a real and present requirement to consider additional MSS allocations below 1 GHz. This section identifies possible allocations for such purpose. It is recognized that the possible access to these allocations will be based on individual system characteristics and their ability to share with other services. The possibilities are as follows:

4.1 Based on the near term requirement for an additional allocation of seven to ten MHz (see par 2.3 above) by around the year 2000, and 13-20 MHz by year 2010, an additional allocation of ten MHz is sought at WRC-95. This section reviews each candidate band in detail and identifies the existing allocation, the current operations ongoing in each band, and the candidate sharing techniques which the NGSO MSS systems could employ to operate successfully in that band. In general, bands which are devoted totally to broadcasting are avoided, as are bands allocated to amateur use, bands with extensive high-powered military systems, bands with extensive flight service or aeronautical navigation allocations, and bands with very heavy civil, industrial and military use. Bands with allocations characterized by intermittent use, such as fixed and mobile services, are considered practical for sharing with NGSO MSS operations. Dynamic channel type operations in the Earth-to-satellite direction are effective since they can operate during the time gaps between uses of the fixed and mobile systems. Spread-spectrum systems can also operate effectively in these bands due to the low pfd's which are enabled from spreading the signal over one megahertz or more. In some bands allocated to fixed and mobile systems, other space type allocations are

already in place, indicating that fixed, mobile, and space systems have already been able to share common bandwidth. NGSO MSS operations need to have separate bands for respective uplink and downlink operations. For common antenna use in the uplink and downlink bands, the frequencies must be relatively close, but must also be separated by about 15% to avoid self interference. Frequencies below about 120 MHz are not suitable to NGSO MSS due to the large antenna size required to communicate effectively with a satellite. Conversely, transceivers for frequencies above 1 GHz require too much power, and are currently too expensive for low-cost satellite based data messaging and positioning services.

A spread-sheet with the candidate bands for NGSO MSS additional allocation is at Appendix C which contains detailed information on each of the bands identified briefly here. The candidate bands are divided into three general priorities:

PRIORITY ONE. This highest priority is based on the expectation that additional spectrum can be allocated to the NGSO MSS on a worldwide basis most easily, either because space activities are already operating in the spectrum, or because the spectrum has already been identified to some degree as potentially available for NGSO MSS operations. Allocation of frequency to the NGSO MSS in any of these bands would require approval by the US administration and action at WRC-95. Four frequency bands in this category are:

138-144 MHz: This band is very similar to the already allocated 148.0-149.9 MHz band, and is already allocated to a space service (space-to-Earth) in all three ITU regions. The intermittent nature of the existing services in this band is ideal for sharing with the short transmission bursts of the NGSO MSS systems. Could be allocated as downlink, matched with comparable uplink bandwidth in the 115-230 MHz or 380-400 MHz bands.

225-230 MHz and 380-400 MHz: The FCC has identified these bands as having potential for NGSO MSS operations depending upon the concurrence of NATO countries. Downlink and/or uplink can be accommodated in both ends of these bands.

312-315 MHz and 387-390 MHz: Across Regions 1,2 & 3, fixed and mobile services have a primary allocation in the wider bands covering these frequencies (273-322 MHz and 335.4-399.9 MHz), but ITU footnote 641 also allocates these bands to the mobile-satellite service on a non-interference basis under Article 14. Other administrations are currently authorizing mobile-satellite operations in these bands. In the U.S. the two bands covering these frequencies are allocated to government use.

399.9-400.05 MHz: This band is currently used by TRANSIT, which will cease operations by 1 January 1997. It is the companion band to 149.9-150.05 MHz, which was allocated to NGSO MSS at WARC-92. It has been allocated to MOBILE SATELLITE on a co-primary basis in the US by FCC Report and Order FCC 93-29, Adopted January 14, 1993.

PRIORITY TWO. Bands for consideration in this priority are those with which the NGSO MSS service can successfully share, but which have allocations for other services such as broadcasting that may make world wide allocation more difficult to achieve in the short term. Candidate priority two bands are:

157.0375-174 MHz: Currently allocated to FIXED and MOBILE in the U.S. for the government, it also contains allocations to MARITIME MOBILE and LAND MOBILE for non-government use. This band could be used for NGSO MSS use in the space-to-ground direction. In some countries in regions 1 and 3 this band is allocated to broadcasting.

470-512 MHz and 512-806 MHz: These bands are currently used for TV broadcasting channels 14 through 69. If there is a transition to HDTV users may no longer use analog systems at VHF. Thus, the bands may become available for reallocation to other services. These bands could become a permanent home for NGSO MSS. In addition, spread-spectrum systems do have the potential to operate effectively in the presence of some broadcasting services without harmful interference.

LOWEST PRIORITY BANDS: These bands generally have allocations to both the military and non-government in the U.S., and are heavily used. However, the services in these bands are generally those which can share with the NGSO MSS due to the nature of their intermittent operation. Bands in the 800 and 900 MHz rang are less desirable than lower band ranges due to the increased power levels needed for operation. Bands considered are:

806-824 MHz

896-901 MHz

932-935 MHz

941-944 MHz

935-941 MHz

944-960 MHz

5.0 RESOLUTION 46

The U.S. has had some experience in the Application of Resolution 46. In addition both the Radiocommunication Bureau and Task Group 8/3 have analyzed Resolution 46. The conclusion is that it is working, but there are some areas for improvement. The results of these analyses and an indication of areas for improvement are identified below.

5.1 The Radiocommunication Bureau

The Radiocommunication Bureau considers that the requirements for coordination in Section II of the annex to Resolution 46 encompass, among other cases, the coordination of transmitting and receiving space stations using non-geostationary satellites vis-a-vis stations in terrestrial services. Although Resolution 46 is mainly applicable to non-geostationary satellite networks, its coordination procedures involving transmitting space stations and terrestrial stations is extended to geostationary space stations through references contained in the relevant Article 8 footnotes

Pursuant to paragraph 2.5 of the Annex to Resolution 46, the basic criterion for identifying the frequency assignments to be taken into account is frequency overlap with the planned assignment. In addition, for the transmitting space station, a coordination threshold based on power flux-density values is usually applicable to the space-to-Earth allocation subject to Resolution 46 coordination.

The Radiocommunication Bureau includes in its RES46/C Special Section, the information relating to the administrations that may be affected, as requested in footnote 2.7.2.1 of the Annex to Resolution 46 (space services using geostationary and/or non-geostationary satellites and terrestrial services). The resulting list of administrations is based on the frequency overlap criterion and takes into account, regarding the terrestrial services, any power-flux density threshold that may apply to the frequency band under consideration.

In its examination of notices for notification, the Bureau has to verify, among other things, whether the coordination requirements of Section III of the Annex to Resolution 46 are met (coordination of each station of a non-geostationary satellite network with terrestrial stations). For this purpose, the Radiocommunication Bureau has developed a computer program to identify the countries with which coordination has to be effected on the basis of the method described in footnote 1 of paragraph 3.1 of the Annex to Resolution 46. A sample of the output report of this computer program is shown in Annex 1, "Transmitting Earth Station Coordination Contours".

5.2 Suggested Areas of Improvement

5.2.1 Coordination of Non-GSO MSS space stations and terrestrial stations.

Resolution 46 provides that coordination will take place in accordance with identified band overlap. However, the necessity for some of these coordinations, even where band overlap occurs, can be eliminated if the space-to-Earth pfd threshold is not exceeded.

TG 8/3 noted that the Radiocommunication Bureau has been calculating the maximum achievable pfd based on the minimum altitude of the satellite (perigee) and the maximum space station e.i.r.p. density (in dBW/Hz). This is due to the fact that the present requirements of Appendix 3 of the RR do not provide for enough information to permit a precise calculation of the pfd, at a given point of the earth's surface, of non-geostationary satellites in the MSS. This may result in an overestimation of the interference from these systems into other systems of the terrestrial services.

In this regard, the information requirements of Appendix 3 for non-geostationary satellites in the MSS should be expanded. It needs to take into account the need for Administrations to furnish additional information on the orientation of the satellite transmitting antenna beams. This information will facilitate the calculation of the instantaneous pfd levels as a function of the elevation angle from a point on earth.

5.2.2 Section 2.8 (Res. 46) Coordination between Administrations

This section states that if "the Administration does not agree, it shall within the same period, send to the Administration seeking coordination the technical details of the network or information on terrestrial stations concerned upon which disagreement is based, etc."

Experience suggests that this provision is not being followed. Administrations prefer to make very generalized statements about the need to coordinate without providing any details about the systems with which coordination may or may not be necessary. The entire process will be facilitated, and made more efficient and effective, if such technical information and details are provided. As a means to improve the situation, it may be useful to provide an Appendix to Resolution 46 which calls attention to the kind of information that must be provided.

5.2.3 Type of Modulation

The Bureau of Radiocommunication, when conducting its examination, determined that it should take into account the modulation and type of multiple access. To do this additional information will be required by the BR; this should be identified.

5.2.4 Definitions

In Resolution 46, there are several technical terms for which definitions are requested. These are:

1. Active service arc
2. Sub-satellite active area
3. Coordination region.

6.0 INTERNATIONAL VIEWS

As near as can be determined, the international community is generally supportive of the initiatives under way to improve the ITU regulations governing the operation and coordination of the Little LEO systems, and the effort to obtain additional spectrum allocation. Earlier this year ITU-R 8/3 met in Toronto, Canada to develop several papers in support of sharing techniques, Resolution 46 improvements, and footnote restriction improvements. CITEL, the telecommunications element of the Organization of American States (OAS), met in Ottawa and established a working group on Little LEO matters.

6.1 ITU-R (TG 8/3)

The International Telecommunications Union Radiocommunication Study Groups Task Group 8/3 met in Toronto from 21 to 29 July 1994. The following documents were developed in support of LEO MSS < 1 GHz:

a. Relieving technical constraints on LEO MSS < 1 GHz systems. Document 8-3/16-E, approved on 7/28/94 provided comments on the constraints to LEO MSS < 1 GHz contained in the footnotes to the ITU allocation tables as follows:

- Footnote 608A imposing a pfd limit of - 150 dB(W/m²/4kHz) outside national boundaries was felt to have operational and regulatory difficulties, and that a "trigger value" for coordination with a neighboring administration would be more appropriate. Alternatives to the application were listed.

- Footnote 608B imposing the same hard limit as FN 608A is not necessary since fixed and mobile systems are not authorized users of the band. A generic Mobile Satellite Service allocation would be logical.

- The latest ITU-R sharing studies such as those given in Study Group 8-3/17 should be brought to the attention of administrations listed in Footnote 608C desiring to protect their fixed and mobile systems.

- Footnotes 641 and 641A may be confusing and ambiguous as to the application of Resolution 46 in the case of the secondary mobile satellite service with respect to the primary Fixed and Mobile services.

b. Sharing spectrum with existing users and other LEO MSS systems. Document 8-3/17 identified sharing techniques which could be used by LEO MSS < 1 GHz systems to share the spectrum with existing users to include Fixed and Mobile systems and other space systems. Techniques such as using low pfd, frequency avoidance techniques, band segmentation and cross polarization, among others, were mentioned. It was felt that the sharing techniques identified should become recognized at the ITU since